US Army Corps
of Engineers
Construction Engineering
Research Laboratory

USA-CERL TECHNICAL REPORT N-88/07
August 1988
Technology to Reduce Noise Impacts
of Training Activities

AD-A199 857

Procedures for Estimating the Flat-Weighted Peak Level Produced by Surface and Buried Charges

by
Richard Raspet
Michael T. Bobak

A procedure has been developed for environmental officers and planners to estimate the immediate noise impacts of demolition and explosive operations. This three-step procedure involves finding a peak level at a particular distance, based on data for TNT, then calculating two correction factors, one for the type and weight of explosive and one for how deep the charge is buried. When the reference TNT level and these correction factors are combined, the sum is an estimate of the peak level which that charge will produce in that situation. This can be used to predict the likelihood of complaints and damage, and procedures can be adjusted accordingly. All this can be done manually using tables given in this report. In addition, a computer program to implement this procedure has been developed and installed on the Environmental Technical Information System (ETIS).

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD-A197 857

REPORT DOCUMENTATION PAGE

Form Approved OMB No 0704 0188 Exp Date Jun 30 1986

1a REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution is unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S): USA-CERL TR N-88/07	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION: U.S. Army Construction Engr Research Laboratory; 6b OFFICE SYMBOL (If applicable): CECER-EN	7a NAME OF MONITORING ORGANIZATION
6c ADDRESS (City, State, and ZIP Code): P.O. Box 4005, Champaign, IL 61820-1305	7b ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING/SPONSORING ORGANIZATION: OCE; 8b OFFICE SYMBOL (If applicable): DAEN-ZCE	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State and ZIP Code): 20 Massachusetts Avenue, N.W., Washington, D.C. 20314-1000	10 SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO 4A62720; PROJECT NO A896; TASK NO A; WORK UNIT ACCESSION NO 029

11 TITLE (Include Security Classification)
Procedures for Estimating the Flat-Weighted Peak Level Produced by Surface and Buried Charges (U)

12 PERSONAL AUTHOR(S)
Raspet, Richard; and Bobak, Michael T.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final	FROM ____ TO ____	1988, August	38

16 SUPPLEMENTARY NOTATION
Copies are available from the National Technical Information Service Springfield, VA 22161

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	explosives, estimates, noise, TNT, Demolition, underground explosions
24	02		

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

A procedure has been developed for environmental officers and planners to estimate the immediate noise impacts of demolition and explosive operations. This three-step procedure involves finding a peak level at a particular distance, based on data for TNT, then calculating two correction factors, one for the type and weight of explosive and one for how deeply the charge is buried. When the reference TNT level and these correction factors are combined, the sum is an estimate of the peak level which that charge will produce in that situation. This can be used to predict the likelihood of complaints and damage, and procedures can be adjusted accordingly. All this can be done manually using tables given in this report. In addition, a computer program to implement this procedure has been developed and installed on the Environmental Technical Information System (ETIS).

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT: ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION: UNCLASSIFIED
22a NAME OF RESPONSIBLE INDIVIDUAL: JANE ANDREW	22b TELEPHONE (Include Area Code): (217)352-6511 (ext. 388); 22c OFFICE SYMBOL: CECER-IMT

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

Carl O. Magnell

Carl O. Magnell, PE
Colonel, Corps of Engineers
Commander and Director

FOREWORD

This work was conducted for the Office of the Chief of Engineers (OCE), under Project 4A62720A896, "Environmental Quality Technology"; Task A, "Installation Environmental Management Strategies"; Work Unit 029, "Technology to Reduce Noise Impacts of Training Activities." The OCE Technical Monitor is LTC J. Stratta, DAEN-ZCE.

This work was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (USA-CERL). Dr. R. K. Jain is Chief of USA-CERL-EN. The technical editor was Ms. Jane Andrew, Information Management Office.

COL Carl O. Magnell is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

CONTENTS

TABLES

FIGURES

PROCEDURES FOR ESTIMATING THE FLAT-WEIGHTED PEAK LEVEL PRODUCED BY SURFACE AND BURIED CHARGES

1 INTRODUCTION

Background

Blast noise from Army demolitions often causes residents of nearby communities to complain about noise and damage. An Army installation's environmental officer or planner needs to be able to estimate the immediate noise effects of demolitions activity on the surrounding area when deciding on sites for explosive activities. For infrequent or unusual events, estimates of the effects are needed to avoid complaints or damage to nearby buildings. For noise mitigation purposes, it is desirable to be able to estimate how deep a charge must be buried. For installations where noise control is achieved by limiting the weight of explosive that can be used, it is useful to be able to calculate the equivalent weight of a buried charge.

The long-term impacts of any operation should be evaluated using the procedures of the Installation Compatible Use Zone (ICUZ) program described in Army Regulation (AR) 200-1, Chapter 7.[1] In that method, in brief, noise zones are determined using a C-weighted average level calculated from all activities producing impulse noise. Incompatible land uses can be determined for the zones.

Objective

The objective of this study was to develop a quick method for environmental officers and planners to estimate immediate noise effects of explosives and to estimate possible noise effects of infrequent or unusual explosives operations.

Approach

Damage criteria are usually expressed in terms of flat-weighted peak levels. Existing methods of estimating these levels were reviewed. The best techniques were incorporated into simple procedures involving graphical look-ups. These procedures were described and then illustrated with several practical examples. The estimates of the effect of burial on blast noise were compared to measurements made at two different locations.

The basic equations used in this procedure are discussed in detail in USA-CERL Technical Report (TR) E-17.[2] The accuracy of the procedures for estimating the noise

---

[1] Army Regulation (AR) 200-1, *Environment Protection and Enhancement* (Department of the Army, 15 June 1982).

[2] P. D. Schomer, *Predicting Community Response to Blast Noise*, Technical Report (TR) E-17/AD773690 (U.S. Army Construction Engineering Research Laboratory [USA-CERL], December 1973).

levels for different weather conditions was confirmed in the resea: h described in USA-CERL TR N-13.[3] The validity of the charge burial correction was established in tests performed at Fort Lewis, WA in May 1978 and at Fort Leonard Wood, MO in April 1980. A portion of the results from Fort Leonard Wood is described in USA-CERL TR N-112.[4] These results were compared with the results from the prediction method developed in this report.

The estimation method has been computerized and installed on the Environmental Technical Information System (ETIS) for easy use.

Mode of Technology Transfer

This technical report will be distributed to Army facilities engineers for field use. The Army Environmental Hygiene Agency, as the Army operational noise agency, has been briefed on the procedure. The interactive computer program will be installed on ETIS. After testing, the procedure will be incorporated in a future technical manual on noise mitigation. The algorithms will also serve to support the Department of Defense's *Resource Conservation and Recovery Act (RCRA) Part B Permit Writers' Guidance Manual for Open Burning/Open Detonation.*

---

[3] P. D. Schomer, R. J. Goff, and L. M. Little, *The Statistics of Amplitude and Spectrum of Blasts Propagated in the Atmosphere*, TR N-13/ADA033475 (Vol 1), ADA033361 (Vol 2) (USA-CERL, November 1976).

[4] Richard Raspet, *Use of Aqueous Foam to Mitigate Demolitions Noise*, TR N-112/ADA111446 (USA-CERL, December 1981).

2 PROCEDURE FOR ESTIMATING THE FLAT-WEIGHTED PEAK LEVEL

Three steps are used in estimating the flat-weighted peak level. The first is the determination of the level produced by 0.454 kg (1.0 lb)* of TNT. The second is the calculation of the correction for different weights and types of charges. The final calculation is the correction for depth of burial.

Step 1: Peak Level Due to a 0.454 kg Charge at a Given Distance

Figure 1 displays the peak level in free air from 0.454 kg of TNT as a function of distance in kilometers. (Corrections for charges on the ground are shown on p 13.) The different curves on this figure correspond to different weather conditions. For normal weather conditions, the base curve provides a reasonable estimate, but higher levels can occur. For the initial calculations, the base curve will be used. (The conditions to which each curve applies are given in Chapter 3, in the discussion of the computer program PEAKEST.) For example, the base level of 0.454 kg of TNT at 1000 m (0.62 mi) would be 124 dB.

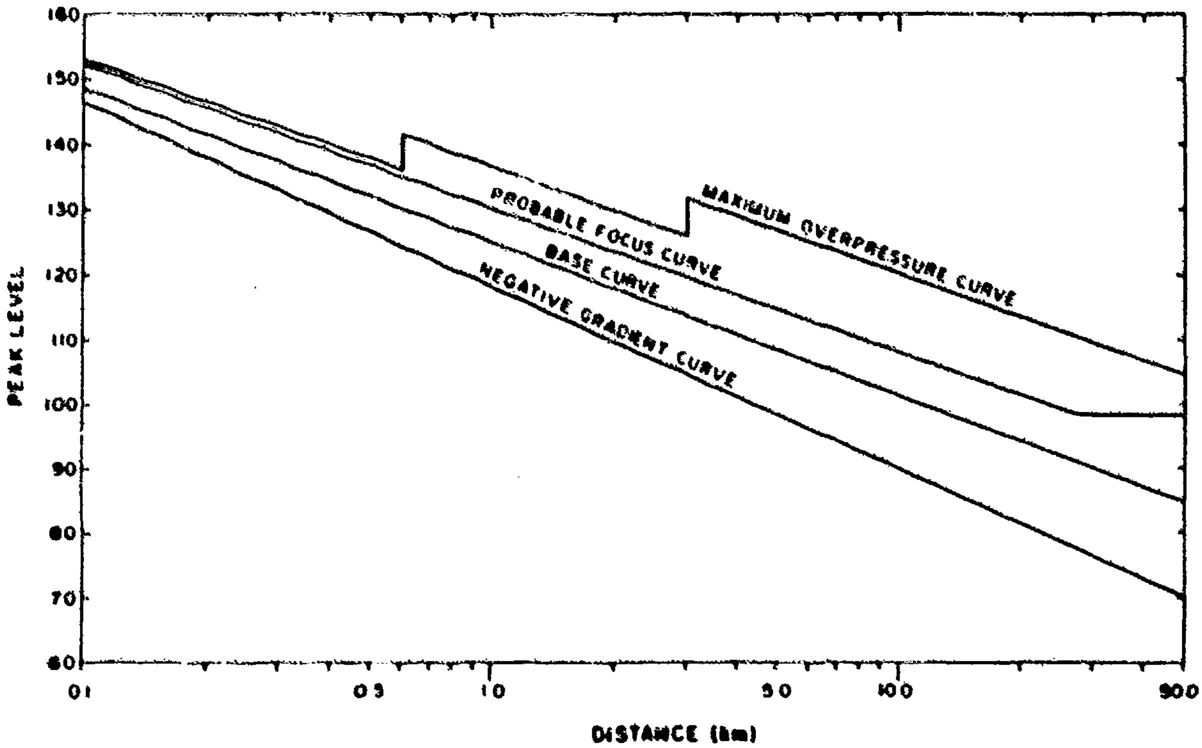

Figure 1. Peak level versus distance for 1 lb (0.454 kg) of TNT in free air.

*Conversion factors are given on p 28.

Step 2: Correction for Weight or Type of Charge

If a different amount or type of explosive is used, the peak level found in Step 1 must be adjusted by a correction factor, Δ. This factor depends on the amount of TNT. Since other types of explosives release different amounts of energy, it is necessary to compare the amount of energy in the charge to that in the standard explosive, TNT. This is done by using an efficiency factor to calculate the equivalent weight of TNT. Table 1 gives this efficiency factor for various military explosives. For example, if one had 5.0 kg of C4, it would be equivalent to 1.34 x 5.0 kg = 6.7 kg of TNT; that is, the efficiency of the C4 times the weight of the C4 in kilograms gives the equivalent weight of TNT. The composition and equivalent weights of some common demolition materials are listed in Table 2.

Once the equivalent weight is known, the correction, Δ, to the peak level can be calculated from $\Delta = 8 \log (w/0.454)$, where w is the weight (or equivalent weight) of TNT. Alternatively, Δ can be looked up in Figure 2. For example, the 6.7 kg equivalent above has a correction of about 9.4 dB.

Table 1

Efficiency Factors for Calculating Equivalent Weights

Explosive		Efficiency
TNT		1.00
Tetrytol, M1, M2		1.30
Composition C3, M3, M5		1.34
Composition C4, M5A1, M112		1.34
Ammonium nitrate (cratering charge)		0.42
Sheet explosive, M186, M118 (demolition charge)		1.14
Military dynamite M1		0.92
Straight dynamite; (Commercial)	40%	0.65
	50%	0.79
	60%	0.83
Ammonia dynamite; (Commercial)	40%	0.41
	50%	0.46
	60%	0.53
Gelatin dynamite	40%	0.42
	50%	0.47
	60%	0.76
PETN		1.66
Tetryl		1.25
Composition B		1.35
Amatol 80/20		1.17
Black Powder		0.55
Nitrostarch		0.80
Pentolite		1.27

Table 2

Common Demolitions and Their Equivalent Weights

Demolition	Explosives	Approximate TNT Equivalent
Demolition Kit, Bangalore Torpedo		
M1A1	4.1 kg Amatol 0.5 kg TNT Booster	5.2 kg
M2A2	4.8 lb Comp B4 0.5 kg A-3 Booster	7.0 kg
Charge, Demolition: Block, 40-lb Cratering	13.6 kg Ammonium Nitrate 4.5 kg TNT	10.3 kg + Booster Charge
Charge, Demolition: Shaped		
(15 lb) M2A3	4.3 kg comp B 0.9 kg PENTOLITE	6.9 kg
(15 lb) M2A4	5.2 kg comp B 0.05 kg A3	7.0 kg
(40 lb) M3	12.8 kg comp B 0.8 kg PENTOLITE	18.3 kg
(40 lb) M3A1	13.8 kg comp B 0.05 kg A3	18.6 kg

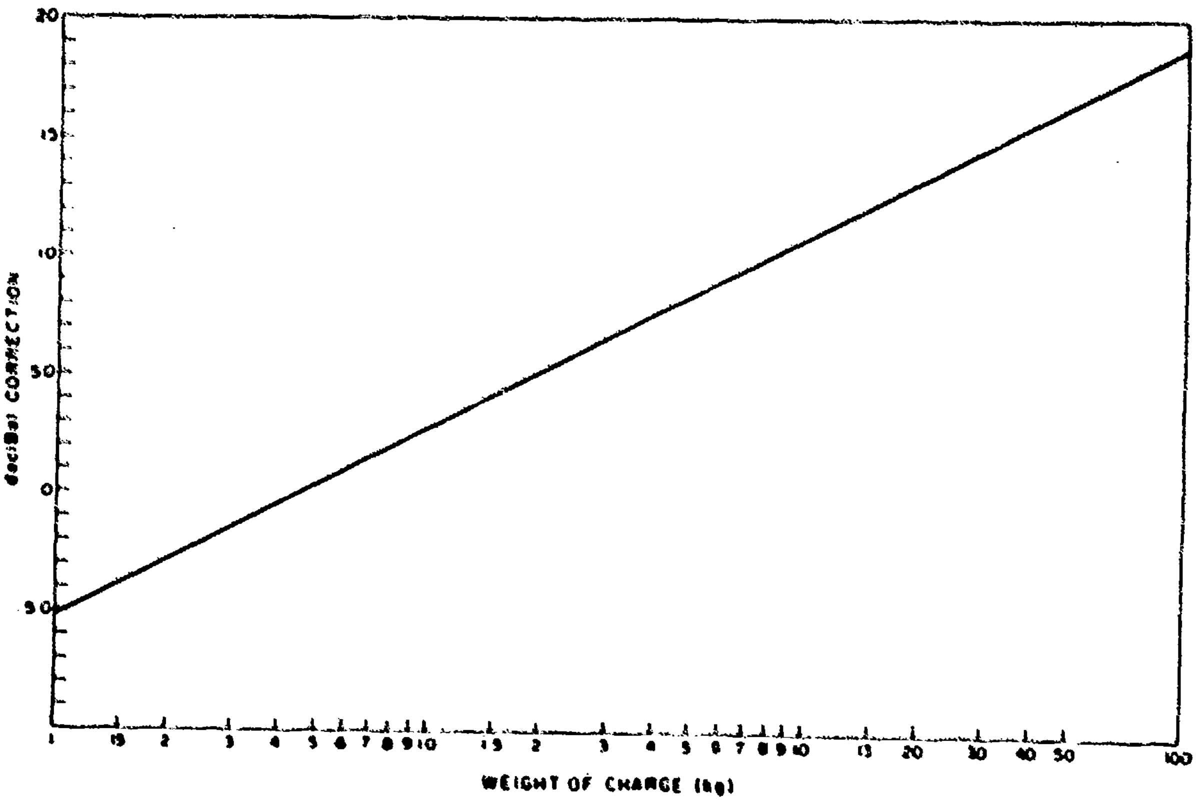

Figure 2. Weight correction chart.

Step 3: Correction for Burial

The depth at which the explosive is buried will reduce the peak level. First, the scaled depth of burial must be calculated. The scaled depth is the depth of the top of the charge in meters divided by the cube root of the charge's equivalent weight in kilograms. The cube root can be looked up on Figure 3. For example, if the C4 charge above, with an equivalent weight of 6.7 kg, were buried 0.50 m, it would have a scaled depth of:

$$\bar{d} = \frac{0.50\ \text{m}}{(6.7\ \text{kg})^{1/3}} = 0.26\ \text{m}/(\text{kg})^{1/3}$$

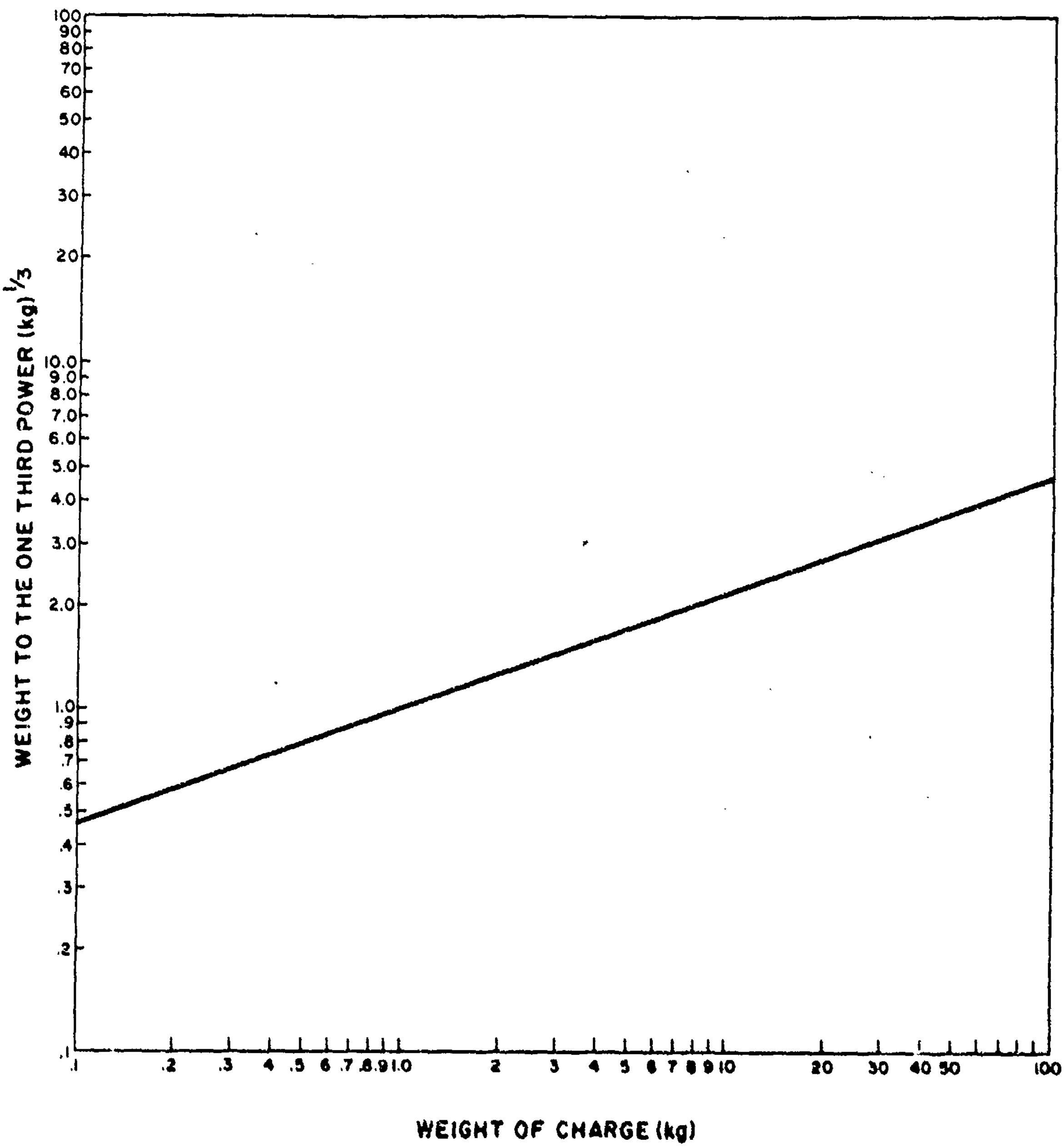

Figure 3. Cube root of weight versus weight.

This scaled depth is used to look up the correction for burial on Figure 4. For this example, the burial correction is 8.0 dB. That is, this charge would be 8.0 dB quieter when buried 0.50 m. (In the remainder of this report, scaled depths are written without units, and $m/kg^{1/3}$ is referred to as "scaled meter.")

Putting these three calculations together, one can calculate the peak level due to 5 kg of C4 buried 0.50 m at a distance of 1000 m:

$$\text{Peak Level} = 124\ \text{dB} + 9.4\ \text{dB} - 8.0\ \text{dB} = 125.4\ \text{dB}$$

Using the principles above one can answer three types of questions.

1. Given the type and weight of charge, depth of burial, and the distance to some critical area, what is the expected peak level?

2. Given a particular charge weight and type, how deep must the charge be buried to be equivalent to a given weight limit?

3. Given a particular charge weight and type, how deep must the charge be buried to keep the peak level under some critical limit at a particular location?

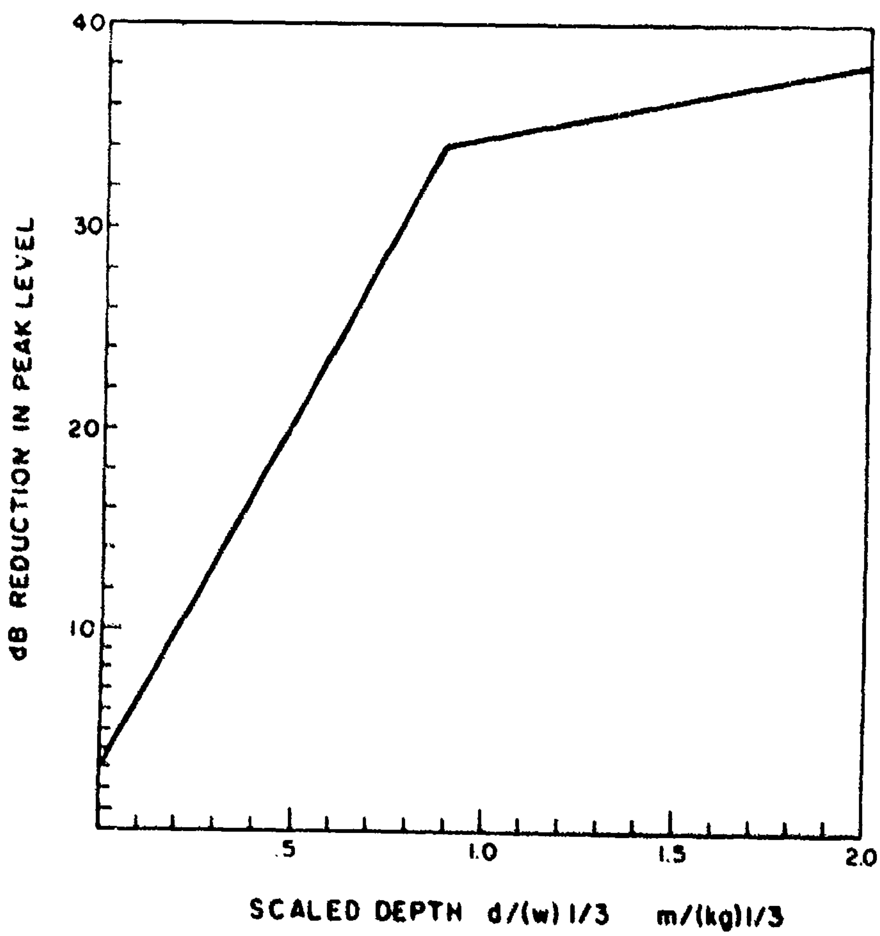

Figure 4. Burial correction chart.

Example 1: Peak Level

Three M2 demolition blocks are buried 1 ft. The demolition site is 400 m from an unoccupied building. Is there a possibility the building will be damaged?

Step 1. Calculate the level due to 0.454 kg of TNT at 400 m. From Figure 1, the base curve value is 134 dB , and the probable focus value is 139 dB.

Step 2. Calculate the equivalent weight of TNT and look up the weight correction. An M2 demolition block contains 2.5 lbs of tetrytol. By Table 2, tetrytol has an efficiency of 1.2. First, calculate the weight of tetrytol in kilograms.

$$3 \text{ blocks} \times 2.5 \text{ lbs/block} \times 0.454 \text{ kg/lbs} = 3.4 \text{ kg}$$

Next, multiply the weight by the efficiency.

$$3.4 \text{ kg} \times 1.2 = 4.1 \text{ kg of TNT}$$

Finally, look up the correction factor in Figure 2.

Weight correction factor = 8.2 dB

Step 3. Calculate the correction factor for burial. Convert the depth of burial to meters.

$$1 \text{ ft} \times 0.3048 \text{ m/ft} = 0.305 \text{ m}$$

Next, calculate or look up the cube root of 4.1 kg. Using Figure 3,

$$(4.1)^{1/3} = 1.6$$

Calculate the scaled depth.

$$0.305 \text{ m}/1.6 = 0.19 \text{ scaled meters}$$

Use Figure 4 to get the depth correction.

Depth correction factor = 9.5 dB

Combining the corrections, the levels are:

base = 134 dB + 8.2 dB - 9.5 dB = 133 dB
probable focus = 139 dB + 8.2 dB - 9.5 dB = 138 dB.

For either of these levels minor damage is possible (Table 3). The charge should be buried deeper, set further from the building, or reduced in size.

Example 2: Burial Depth for Equivalent Weight

How deep would 40 lb of military dynamite have to be buried to be as quiet as 2 kg of TNT above ground?

Table 3

Blast Noise Complaint Potential

Flat Weighted Peak Level	Risk of Complaints
0 - 110	Low
110 - 125	Moderate
125 - 140	High
130 - 140	High; Possibility of Damage Claims
> 140	High; Possible Damage to Structures

Step 1. Calculate the equivalent weight of the dynamite. First, convert to kilograms.

$$40 \text{ lb} \times 0.454 \text{ kg/lb} = 18.2 \text{ kg}$$

Then, by Table 1, the efficiency is 0.92, so the equivalent weight is

$$0.92 \times 18.2 \text{ kg} = 16.7 \text{ kg}.$$

Step 2. Calculate how much louder 40 lb of dynamite is than 2 kg of TNT. By Figure 2, the weight correction for 2.0 kg is 5.2 dB; for 16.7 kg it is 12.5 dB. So the 16.7 kg charge needs to be made

$$12.5 - 5.2 = 7.3 \text{ dB quieter.}$$

Step 3. From Figure 4, the scaled depth necessary to quiet a charge 7.3 dB is about 0.16 scaled meters. To convert to actual depth, multiply the scaled depth times the cube root of the charge weight. By Figure 3, the cube root of 16.7 kg is about 2.6.

So, to be as quiet as 2.0 kg of TNT, the depth the dynamite would have to be buried at is:

$$2.6 \times 0.16 \text{ m} = 0.42 \text{ m}.$$

The charge would have to be buried at least 42 cm.

Example 3: Burial Depth to Maintain Peak Below Limit

How deep must a 40-lb cratering charge boosted by 1.25 lbs of C4 be buried so that the peak sound pressure level will not exceed 115 dB at 2.0 km, under a wide variety of weather conditions?

Step 1. Calculate the level predicted for 0.454 kg at 2.0 km. Use the probable focus curve of Figure 1; this curve gives a level of 124 dB at 2.0 km.

Step 2. Calculate the equivalent charge weight and the weight correction. Table 2 gives the equivalent weight for the 40-lb cratering charge of 10.3 kg + equivalent weight of the booster charge. The booster used is 1.25 lbs of C4. Convert to kilograms and multiply by the efficiency in Table 1.

Booster charge = 1.25 lbs x 0.454 kg/lb x 1.34 = 0.76 kg

The total equivalent weight is 10.3 + 0.76 kg = 11.1 kg of TNT. By Figure 2, the weight correction is 11.4 dB.

Step 3. Calculate how much reduction is needed. The peak level with the charge on the surface would be 123 dB + 11.3 dB = 134.3 dB. The desired level is 115 dB, so the level needs to be reduced by 19.3 dB by burying the charge.

Step 4. Figure 4 indicates that the top of the charge must be 0.6 scaled meters below the surface to achieve that much quieting. To convert to actual depth, multiply by the cube root of the equivalent weight. This can be looked up in Figure 3. The actual depth is:

$$0.61 \text{ m} \times (11.1)^{1/3} = 1.37 \text{ m}$$

So the charge must be buried about 1.3 m for the sound not to exceed 115 dB at 2.0 km.

Case Studies

USA-CERL has performed two studies involving charges on the surface and buried charges.[5] Here, the measured levels will be compared with those predicted by the procedure outlined in this report.

Test 1: Fort Lewis, WA

In test one, three types of charges were fired: (a) 2.3 kg of C4 on the surface, (b) 9.1 kg of C4 buried 60 cm in glacial till, and (c) a 40-lb cratering charge boosted by 1.13 kg of C4 buried 15 cm in glacial till. All levels were measured at 380 m from the charge. Table 4 presents the results of this study.

Table 4

Results of Tests at Fort Lewis, WA in dB

	C-SEL	F-SEL	PEAK
5 lb of C4 in air at 380 m	116.1	118.9	138.8
40-lb cratering charge buried 15 cm in glacial till at 380 m	117.2	120.1	139.4
20 lb of C4 buried 60 cm in glacial till at 380 m	111.2	113.7	133.5

[5] Richard Raspet.

(a) 2.3 kg Charge

- The level due to 0.454 kg of TNT for the base curve at 380 m is 135.0 dB.
- The equivalent weight is 2.3 kg x 1.34 = 3.1 kg.
- The correction from Figure 2 is 6.7 dB.
- There is no correction factor for burial.

The total level predicted is 142 dB. The measured level was 138.8 dB.

(b) 9.1 kg Charge

- The level of 0.454 kg is 135.5 dB.
- The weight equivalent is 1.34 x 9.1 kg = 12.2 kg.
- The weight correction is 11.5 dB, from Figure 2.
- For the scaled depth of burial, the cube root of 12.1 kg is 2.29, from Figure 3; the scaled depth is 0.60m/2.29 = 0261 scaled meters. From Figure 4, the correction is 12 dB.

The total predicted level is 135.5 + 11.5 - 12 = 135.0 dB. The measured average level was 132.

(c) 40-lb Cratering Charge

- Level due to 0.454 kg is 135.5 dB at 390 m
- Weight equivalent by Table 2 is 10.3 kg + equivalent weight of booster. The booster charge was 1.13 kg of C4 so the total equivalent charge was:

$$10.3 \text{ kg} + (1.13 \text{ kg} \times 1.34) = 11.8 \text{ kg}$$

- The weight correction from Figure 2 is 11.4 dB.
- The scaled depth is

$$0.15 \text{ m}/(11.8 \text{ kg})^{1/3} = 0.066 \text{ scaled meters}$$

This reduces the level by about 2 dB.

Thus, the expected base level is 135.5 dB + 11.8 dB - 2.0 dB = 145.3. The measured level was 139.4 dB.

Note that in all these cases, the predicted value was larger than the measured value by 4 to 6 dB. The measurements were made near midday on a windy day. For these conditions the negative focus curve of Figure 1 would be more appropriate. The estimates prepared from the base curves are conservative for negative gradient weather conditions.

Test 2: Fort Leonard Wood, MO

In this test, two sizes of charges were fired: (a) 2.3 kg of charge above ground and (b) a 40-lb cratering charge boosted by 0.57 kg of C4 and buried 60 to 90 cm in sandy loam with an average depth of 75 cm. Microphones were placed at 152 m and 304 m. See Table 5 for the avercge levels.

Table 5

Results of Tests at Fort Leonard Wood, MO in dB

	C-SEL	F-SEL	PEAK
1 1/4 lb of C4 in air			
At 152 m	122.8	125.5	148.2
At 304 m	114.7	117.1	138.7
5 lb of C4 in air			
At 152 m	127.7	131.7	153.2
At 304 m	118.8	123.0	145.0
40-lb cratering charges buried 60 to 90 cm in sandy loam			
At 152 m	116.9	122.8	142.8
At 304 m	109.4	114.9	134.5

(a) 2.3 kg charge

- The levels due to 0.454 kg of TNT using the base curve of Figure 1 at 152 and 305 m, respectively, are 145.0 dB and 138.0 dB.
- The equivalent weight is 1.34 x 2.3 kg = 3.1 kg.
- The weight correction is 6.7 dB.
- No correction for burial.

The total predicted peak levels are 151.7 dB and 144.7 dB. The measured levels were 148.2 dB and 138.7 dB.

(b) 40-lb Cratering Charge with 0.57 kg C4 Booster

- Levels due to 0.454 kg of TNT are 145.0 and 138.0 dB at 152 m and 305 m, respectively.
- The equivalent weight from Table 2 is 10.3 kg + 1.34 x 0.57 kg = 11.1 kg.
- The weight correction is 11.5 dB.
- The scaled depth of burial is the average depth divided by $(11.1)^{1/3}$, or 0.75 m/2.2 = 0.34 scaled meters.
- The correction from Figure 4 is -14.7 dB.

Thus the total levels predicted at 152 m and 305 m are 141.8 dB and 134.8 dB. The measured average values were 142.8 dB and 134.5 dB.

Again, the predicted values are higher than those measured, so the procedure is a conservative one. The test values in this case would be better represented if the negative gradient curve on Figure 4 were used.

The calculations described in this chapter result in reasonable predictions of overpressure for surface and buried charges. Unless care is taken to fire only under favorable conditions (Table 6), the probable focus curve should be used for predictions.

Conditions to be avoided are:

- Nighttime and 2 hr before sunset and 2 hr after sunrise
- Calm days during the presence of high pressure areas
- Times when there are stable cloud layers
- Times when there are wind shears aloft.

The curves in Figure 1 cannot be used for propagation over water. The levels would be much higher in that case.

Table 6

"Good" and "Bad" Firing Conditions

Good Conditions	Bad Conditions
Clear skies with billowy cloud formations, especially during warm periods of the year	Days of steady winds of 5-10 mph with gusts of greater velocities (above 20 mph) in direction of residences close by
A rising barometer immediately following a storm	Clear days on which "layering" of smoke or fog is observed
	Cold, hazy, or foggy mornings
	Days following a day when large extremes of temperature (about 20°C) between day or night were noted
	Generally high barometer readings with low temperatures

3 USING OF THE PROGRAM "PEAKEST"

The procedures described in Chapter 2 have been computerized for use on the Environmental Technical Information System (ETIS).* This chapter demonstrates the use of this program, PEAKEST, to perform the examples given in Chapter 2. The user is prompted for inputs and the program uses equations to calculate the values that were looked up on the graphs in the manual procedure. A record of an actual interactive session is given below. Any external comments or explanations are given in parentheses, and input from the user is underlined. To run PEAKEST on ETIS, do the following steps.

Type <u>etis</u> to access the ETIS system.
Type <u>10</u> for the misc directory.
Type <u>peakest</u> to start the program.

(This is the introduction given at the start of every session.)

This program makes peak level noise predictions for explosions and possible effects of the predicted levels. The program is useful for siting explosives operations and for assessing infrequent or unusual explosives operations. Note that any long term operations MUST be assessed by the procedures of AR 200-1 and the Installation Compatible Use Program. This program cannot be used over water. All through this program you will be asked (Yes/No) questions. The computer reads the first letter of your response so a y or n will suffice or you can just hit a return to continue. All weights are in kilograms and all distances are in meters. The program provides weather predictions for three weather conditions and maximum level curve. Do you want a short listing of these conditions (Y/N)? <u>y</u>

Negative gradient- Sunny day, cumulus clouds, midday, windy

Base- Low winds, clouds, fall and winter, daytime

Focus- Low stable clouds, very low winds (<2 m/s), nighttime to 2 hr after sunrise, winter and fall

Maximum possible overpressure- Rare, but levels will sometimes occur under extreme focus conditions.

Do you want a copy of this introduction (Y/N)? <u>y</u>
Do you want a copy of this session saved in a storage file (Y/N)? <u>y</u>
ok it will be in fort 7

(Example 1)

(Find the base level for three blocks of M1 buried 1 ft at 400 m.)

Do you want a standard demolition charge? (Y/N) <u>n</u>
Do you want an explosive other than TNT? (Y/N) <u>y</u>

(The program prints out your choices.)

---

*ETIS may be accessed through the ETIS Support Center, Department of Urban and Regional Planning, University of Illinois. Users may obtain a login from the Center by calling (217) 333-1369.

1) TNT
2) Tetrytol,M1,M2
3) Comp. C3,M3,M5
4) Comp. C4,M5A1,M112
5) Ammonium nitrate
6) Sheet expl., M186,M118
7) Military dynamite, M1

Straight dynamite

8) 40%
9) 50%
10) 60%
11) PETN

Ammonia dynamite

13) 40%
14) 50%
15) 60%

Gelatin dynamite

16) 40%
17) 50%
18) 60%
19) Tetryl
20) Comp. B
21) Amatol 80/20
22) Black Powder

(You want M1 explosive, so pick number 2.)

```
Enter explosive type number 2
Weight is 1.00
Change? (Y/N) -> y
```

(You want 3 blocks x 2.5 lbs/block x 0.454 kg/lb = 3.4 kg.)

```
Enter new value of weight  ->   3.40
distance is  1000.00
Change? (Y/N) -> y
```

(Change the distance from the default to 400 m.)

```
Enter new value of distance ->  400.00
depth is   0.00
Change?  (Y/N) -> y
```

(The charge is to be buried at 1 ft = 0.3048 m.)

```
Enter new value of depth  ->  0.30
equivalent wt=  4.08 distance = 400.00 depth= 0.30
```

(Here is the equivalent weight [weight x efficiency] and the input values.)

```
hit C to change the distance or depth, return to continue
```

(This gives you a chance to correct errors. There are not any here, so hit return to continue; you get the levels with appropriate suggestions.)

```
Suggestions:
For negative gradient conditions the level is 128
There is a high risk of complaints

For base conditions the level is 133
There is a high risk of complaints
There is a possibility of damage complaints
```

For focus conditions the most probable level is 137
There is a high risk of complaints
There is a possibility of damage complaints

The maximum level possible is 138
There is a high risk of complaints
There is a possibility of damage complaints

hit x to exit, n for a new weight, return to continue

(x was pressed to exit. A new session was started to illustrate Example 2. You can avoid this by picking n instead of x when asked if you want to exit.)

(Example 2)

(How deep would 40 lb of military dynamite have to be buried to be as quiet as 2 kg of TNT above ground?)

Do you want a standard demolition charge? (Y/N) n

(First find the level for 2 kg of TNT so take the default of TNT.)

Do you want an explosive other than TNT (Y/N) n
weight is 1.00
Change? (Y/N) -> y
Enter new value of weight -> 2.00
distance is 1000.00

(You just want to compare two explosive types without varying the distance so just stay with the default distance.)

Change? (Y/N) -> n
depth is 0.00
Change? (Y/N) -> n

(The 2 kg charge is not buried.)

equivalent wt = 2.00 distance = 1000.00 depth = 0.00
hit C to change the distance or depth, return to continue

(Hit return to get the results for 2 kg of TNT.)

Suggestions:
For negative gradient conditions the level is 122
There is a high risk of complaints

For base conditions the level is 129
There is a high risk of complaints

For focus conditions the most probable level is 133
There is a high risk of complaints
There is a possibility of damage complaints

The maximum level possible is 139
There is a high risk of complaints
There is a possibility of damage complaints

hit x to exit, n for a new weight, return to continue

(Hit n to enter a new weight and explosive type.)

Do you want a standard demolition charge? (Y/N) n
Do you want an explosive other than TNT? (Y/N) y

(The program prints out the choices.)

1) TNT
2) Tetrytol,M1,M2
3) Comp. C3,M3,M5
4) Comp. C4,M5A1,M112
5) Ammonium nitrate
6) Sheet expl., M186,M118
7) Military dynamite,M1
Straight dynamite
8) 40%
9) 50%
10) 60%
11) PETN
Ammonia dynamite
13) 40%
14) 50%
15) 60%
Gelatin dynamite
16) 40%
17) 50%
18) 60%
19) Tetryl
20) Comp. B
21) Amatol 80/20
22) Black Powder

(Now you want to get levels for military dynamite, so pick number 7.)

Enter explosive type number 7
weight is 2.00
Change? (Y/N) y

(You want 40 lb x 0.454 kg/lb = 18.16 kg.)

Enter new value of weight -> 18.16

(Keep the distance constant and change the other variables.)

distance is 1000.00
Change? (Y/N) -> n
depth is 0.00
Change? (Y/N) -> y

(Now, because there is no built-in formula for picking a depth which will give a certain level (one less than for 2 kg of TNT), you will have to guess a depth. Then look at the levels, and bury the charge deeper if you need the levels to be lower, or reduce the burial depth if the levels are quieter than the 2 kg of TNT. The first guess was 0.3 m.)

Enter new value of depth -> 0.30
equivalent wt = 16.71 distance = 1000.00 depth = 0.30
hit C to change the distance or depth, return to continue

(Hit continue to see results of the first guess.)

Suggestions:
For negative gradient conditions the level is 124
There is a high risk of complaints

For base conditions the level is 131
There is a high risk of complaints
There is a possibility of damage complaints

For focus conditions the most probable level is 136
There is a high risk of complaints
There is a possibility of damage complaints

The maximum level possible is 142
Complaints are likely
Possible damage to structures

hit x to exit, n for a new weight, return to continue

(These levels are louder than the 2 kg of TNT, so the 40-lb charge needs to be buried deeper: hit return to continue.)

distance is 1000.00
Change? (Y/N) -> n
depth is 0.30
Change? (Y/N) -> y

(You want to bury it deeper, so input 0.65 m.)

Enter new value of depth -> 0.65
equivalent wt = 16.71 distance = 1000.00 depth = 0.65
hit C to change the distance or depth, return to continue

(Hit return to see the results of the second guess.)

Suggestions:
For negative gradient conditions the level is 120
There is a moderate risk of complaints

For base conditions the level is 127
There is a high risk of complaints

For focus conditions the most probable level is 131
There is a high risk of complaints
There is a possibility of damage complaints
The maximum level possible is 137
There is a high risk of complaints
There is a possibility of damage complaints

hit x to exit, n for a new weight, return to continue

(It might take a few more guesses to get the exact levels but for now it is close enough.)

(x was pressed to exit, and a new session was started for Example 3. You can avoid this by picking n instead of x when asked if you want to exit.)

(Example 3)

(How deep must you bury a 40-lb cratering charge so the probable focus levels will be under 115 dB?)

(This charge is one of the standard explosives listed in this report.)

Do you want a standard demolition charge? (Y/N) y

(When you ask for a standard charge, you are provided with a listing.)

1) M1A1 bangalore torpedo
2) M2A2 bangalore torpedo
3) 40 lb cratering charge
4) M2A3 15 lb shaped charge
5) M2A4 15 lb shaped charge
6) M3 40 lb shaped charge
7) M3A1 40 lb shaped charge

Enter explosive type number 3
Will you use more than one standard charge? (Y/N) n

(If you wanted to use more than one cratering charge you should answer yes here.)

Do you want to add a booster? (Y/N) y

(Yes, to add a booster.)

Pick an explosive type

1) TNT
2) Tetrytol,M1, M2
3) Comp. C3,M3,M5
4) Comp. C4,M5A1,M112
5) Ammonium nitrate
6) Sheet expl., M186,M118
7) Military dynamite,M1
Straight dynamite
8) 40%
9) 50%
10) 60%
11) PETN
Ammonia dynamite
13) 40%
14) 50%
15) 60%
Gelatin dynamite
16) 40%
17) 50%
18) 60%
19) Tetryl
20) Comp. B
21) Amatol 80/20
22) Black Powder

(The booster is C4, so pick number 4.)

Enter explosive type number 4

(You want 1.25 lb x 0.45 kg/lb.)

Enter total weight of ALL boosters -> 0.57
distance is 1000.00
Change? (Y/N) -> y

(Go to 2 km = 2000 m)

Enter new value of distance -> 2000.00
depth is 0.00
Change? (Y/N) -> y

(Now you start guessing as in Example 2. The first guess was 0.5 m.)

(Remember, just bury deeper until you get the desired level (115 dB in this example) or lower.)

Enter new value of depth -> 0.50
equivalent wt = 11.06 distance = 2000.00 depth = 0.50
hit C to change the distance or depth, return to continue

Suggestions:
For negative gradient conditions the level is 111
There is moderate risk of complaints

For base conditions the level is 119
There is a high risk of complaints

For focus conditions the most probable level is 124
There is a high risk of complaints

The maximum level possible is 130
There is a high risk of complaints

hit x to exit, n for a new weight, return to continue

(Hit return to continue.)

distance is 2000.00
Change? (Y/N) -> n
depth is 0.50
Change? (Y/N) -> y

(Try a bit deeper, say 1.2 m.)

Enter new value of depth -> 1.20
equivalent wt = 11.06 distance = 2000.00 depth = 1.20
hit C to change the distance or depth, return to continue

Suggestions:
For negative gradient conditions the level is 99
There is little risk of complaints

For base conditions the level is 108
There is little risk of complaints

For focus conditions the most probable level is 113
There is moderate risk of complaints

The maximum level possible is 118
There is a moderate risk of complaints
hit x to exit, n for a new weight, return to continue
distance is 2000.00
Change? (Y/N) -> n
depth is 1.20
Change? (Y/N) -> y

(Do not need to go that deep.)

Enter new value of depth -> 1.10
equivalent wt = 11.06 distance = 2000.00 depth = 1.40
hit C to change the distance or depth, return to continue

Suggestions:
For negative gradient conditions the level is 102
There is little risk of complaints

For base conditions the level is 110
There is little risk of complaints

For focus conditions the most probable level is 115
There is moderate risk of complaints

The maximum level possible is 121
There is a high risk of complaints
hit x to exit, n for a new weight, return to continue
distance is 2000.00
Change? (Y/N) -> n
depth is 1.40
Change? (Y/N) -> y

(Just about five centimeters more should do it.)

Enter new value of depth -> 1.15
equivalent wt = 11.06 distance - 2000.00 depth - 1.45
hit C to change the distance or depth, return to continue

Suggestions:
For negative gradient conditions the level is 101
There is little risk of complaints

For base conditions the level is 109
There is little risk of complaints

For focus conditions the most probable level is 114
There is moderate risk of complaints

The maximum level possible is 120
There is a moderate risk of complaints

hit x to exit, n for a new weight, return to continue

(Hit x to exit; you're finished.)

4 CONCLUSION

This report has described a quick method for the environmental officer or planner to estimate the possible noise effects of explosive operations. This three-step procedure can be done manually by looking up values on the tables and graphs provided in this report, then using these values to calculate the peak level in various situations. The procedure has also been successfully implemented as a computer program on the Environmental Technical Information System (ETIS).

METRIC CONVERSION FACTORS

1 lb = 0.454 kg
1 ft = 0.3048 m
1 mi = 1.609 km
1 in. = 25.4 mm

APPENDIX:

COMPUTER PROGRAM LISTING

In the following listing of the FORTRAN source code, for PEAKEST, the ->-> marks appearing at the left margin indicate lines that had to be broken to fit on smaller paper.

```
c     get type of blast(wt in tnt or standard or wt of standard type)
c     then get depth and distance to charge
        real blev(4),wt(7),ef(23)
c arrays are for the blast level, charge wieght and efficiency respectively
        integer exptyp,bsttyp,stdtyp
c integers: explosive type for charge or booster and standard demolition type
        character ans,name1(8),name2(8),name3(8),name4(8)
        data name1/'w','e','i','g','h','t',' ',' '/
        data name2/'d','i','s','t','a','n','c','e'/
        data name3/'d','e','p','t','h',' ',' ',' '/
        data name4/'n','u','m','b','e','r',' ',' '/
        call strtinfo(iw)
        exptyp=1
        m1=28.2
        m2=23.5
        m3=22.5
        m4=23.0
        m42=23.0
        m43=23.0
        wt(1)=5.2
        wt(2)=7.
        wt(3)=10.3
        wt(4)=6.9
        wt(5)=7.
        wt(6)=18.3
        wt(7)=18.6
        ef(1)=1.
        ef(2)=1.2
        ef(3)=1.34
        ef(4)=1.34
        ef(5)=.42
        ef(6)=1.14
        ef(7)=.92
        ef(8)=.65
        ef(9)=.79
        ef(10)=.83
        ef(11)=1.66
        ef(12)=1.25
        ef(13)=.41
        ef(14)=.46
        ef(15)=.53
        ef(16)=.42
        ef(17)=.47
        ef(18)=.76
        ef(19)=1.25
        ef(20)=1.35
        ef(21)=1.17
        ef(22)=.55
        ef(23)=.8
c     default values
        weight=1.00
        stdnum=1.0
        exptype=1
        dist=1000.0
c     end defaults
        stdtyp=0
2       write(6,"('Do you want a standard demolition charge? (Y/N)  ',$)")
        read(5,"(a)") ans
        if(iw.eq.1)write(7,"('Do you want a standard demolition charge? (Y/N)  '
->->    ,$)")ans
```

```
                  if((ans.eq.'y').or.(ans.eq.'Y'))then
                          write(6,"('1)  M1A1 bangalore torpedo')")
                          write(6,"('2)  M2A2 bangalore torpedo')")
                          write(6,"('3)  40 lb cratering charge')")
                          write(6,"('4)  M2A3  15 lb shaped charge')")
                          write(6,"('5)  M2A4  15 lb shaped charge')")
                          write(6,"('6)  M3    40 lb shaped charge')")
                          write(6,"('7)  M3A1  40 lb shaped charge')")
                          write(6,"('Enter number of the explosive type ',$)")
                          read(5,"(i2)")stdtyp
                          if(iw.eq.1)write(7,"('Enter number of the explosive type ',i2)")
->->      stdtyp
                          write(6,"('Will you use more than one standard charge? (Y/N) ',$
->->      )")
                          read(5,"(a)") ans
                          if(iw.eq.1)write(7,"('Will you use more than one standard charge
->->      ? (Y/N) ',a)")ans
                          if((ans.eq.'y').or.(ans.eq.'Y')) then
                                  call getval(stdnum,name4,iw)
                          endif
                          write(6,"('Do you want to add a booster? (Y/N) ',$)")
                          read(5,"(a)") ans
                          if(iw.eq.1)write(7,"('Do you want to add a booster? (Y/N) ',a)")
                          ans
                          if((ans.eq.'y').or.(ans.eq.'Y'))then
                                  write(6,"('Pick an explosive type')")
                                  if(iw.eq.1)write(7,"('Pick an explosive type')")
                                  call getet(ans,bsttyp,iw)
                                  bw=0.
                                  write(6,"('Enter total weight of all boosters -> ',$)")
                                  read(5,*) bw
                                  if(iw.eq.1)write(7,"('Enter total weight of all boosters
->->      -> ',f9.2)")bw
                          endif
                          weight=stdnum*wt(stdtyp)+bw*(ef(bsttyp))
                  endif
                  if(stdtyp.ne.0)goto3
                  write(6,"('Do you want an explosive other than TNT? (Y/N) ',$)")
                  read(5,"(a)") ans
                  if(iw.eq.1)write(7,"('Do you want an explosive other than TNT? (Y/N) ',a
->->      )")ans
                  call getet(ans,exptyp,iw)
          c     get weight distance and depth
                  write(6,"('weight is ',f9.2)")weight
                  if(iw.eq.1)write(7,"('weight is ',f9.2)")weight
                  call getval(weight,name1,iw)
          c     efficiency correction
                  weight=weight*ef(exptyp)
          3       do 4,it=1,20
          7       write(6,"('distance is ',f9.2)")dist
                  if(iw.eq.1)write(7,"('distance is ',f9.2)")dist
                  call getval(dist,name2,iw)
                  if((dist.gt.50000).or.(dist.lt.100)) write(6,"('Out of range of program'
                  )")
                  if((dist.gt.50000).or.(dist.lt.100).and.iw.eq.1) write(7,"('Out of range
->->      of program')")
                  write(6,"('depth is ',f9.2)")depth
                  if(iw.eq.1)write(7,"('depth is ',f9.2)")depth
                  call getval(depth,name3,iw)
                  write(6,"('eqivalent wt= ',f7.2,' distance = ',f8.2,' depth= ',f7.2,/' h
->->      it C to change the distance or depth,return to continue')")weight,dist,depth
                  read(5,"(a)") ans
                  if(iw.eq.1)write(7,"('eqivalent wt= ',f7.2,' distance = ',f8.2,' depth=
->->      ',f7.2,/' hit  C to change the distance or depth, return to continue')")weight,d
->->      ist,depth
                  if((ans.eq.'c').or.(ans.eq.'C'))goto7
          c     calculate the 4 base levels
                  blev(1)=146.5-m1*alog10(dist/100.0)
                  blev(2)=148.5-m2*alog10(dist/100.0)
                  blev(3)=152.-m3*alog10(dist/100.0)
                  if(dist.ge.27400)blev(3)=98.4
                  if(dist.le.600.)blev(4)=153.-m4*alog10(dist/100.0)
                  if(dist.gt.600.0.and.dist.le.3000.)blev(4)=159.0-m42*alog10(dist/100.0)
                  if(dist.gt.3000.)blev(4)=165.0-m43*alog10(dist/100.0)
```

```
c     weight correction
        wtcorr=8*alog10(weight/.454)
        blev(1)=blev(1)+wtcorr
        blev(2)=blev(2)+wtcorr
        blev(3)=blev(3)+wtcorr
        blev(4)=blev(4)+wtcorr
c     burial correction
        cdepth=depth/(weight**.3333)
        burcor=cdepth*34.44+3.
        if(cdepth.gt.0.9)burcor=(cdepth-0.9)*1.9+34.
        blev(1)=blev(1)-burcor
        blev(2)=blev(2)-burcor
        blev(3)=blev(3)-burcor
        blev(4)=blev(4)-burcor
c     check for warnings
        do 21 i6=6,7
        if(iw.ne.1.and.i6.eq.7)goto21
        write(i6,"('Suggestions:')")
        write(i6,"('------------------------------------------------------------
->->  -------------------')")
        do 20 i=1,4
c      round at .5
        blevi=blev(i)+0.5
        if(i.eq.1)write(i6,"('For negative gradient conditions the level is ',f9
->->  .0)") blevi
        if(i.eq.2)write(i6,"('For base conditions the level is ',f9.0)") blevi
        if(i.eq.3)write(i6,"('For focus conditions the most probable level is',f
->->  9.0)") blevi
        if(i.eq.4)write(i6,"('The maximum level possible is',f9.0)") blevi
        if(blev(i).lt.110.)write(i6,"('There is little risk of complaints')")
        if(blev(i).ge.110.0.and.blev(i).lt.120)write(i6,"('There is moderate ris
->->  k of complaints')")
        if(blev(i).ge.120.0.and.blev(i).lt.140)write(i6,"('There is a high risk
->->  of complaints')")
        if(blev(i).ge.130.0.and.blev(i).lt.140)write(i6,"('There is a possibilit
->->  y of damage complaints')")
        if(blev(i).ge.140.0)write(i6,"('Complaints are likely')")
        if(blev(i).ge.140.0)write(i6,"('Possible damage to structures')")
        write(i6,"('------------------------------------------------------------
->->  -------------------')")
20      continue
21      continue
        write(6,"('hit x to exit, n for a new weight, return to continue ',$)")
        read(5,"(a)") ans
        if((ans.eq.'x').or.(ans.eq.'X'))goto5
        if((ans.eq.'n').or.(ans.eq.'N'))goto2
4       continue
        if(iw.eq.1)write(7,"('end of session')")
5       write(6,"('end of session')")
        end

        subroutine getval(val,word,iww)
        character ans,word(8)
        write(6,"('Change? (Y/N) -> ',$)")
        read(5,"(a)") ans
        if(iww.eq.1)write(7,"('Change? (Y/N) -> ',a)")ans
        if((ans.eq.'y').or.(ans.eq.'Y'))goto9
        return
9       write(6,"('Enter new value of ',8a1,' -> ',$)")word
        read(5,*) val
        if(iww.eq.1)write(7,"('Enter new value of ',8a1,' -> ',f12.2)")word,val
        return
        end
```

```
c get the explosive type
        subroutine getet(answ,exptyp,iww)
        character answ
        if((answ.eq.'y').or.(answ.eq.'Y'))then
                write(6,"(' 1) TNT                           Ammonia dynamite')")
                write(6,"(' 2) Terytol,M1,M2              13)      40%')")
                write(6,"(' 3) Comp.C3,M3,M5              14)      50%')")
                write(6,"(' 4) Comp.C4,M5A1,M112          15)      60%')")
                write(6,"(' 5) Ammonium nitrate            Gelatin dynamite')")
                write(6,"(' 6) Sheet expl.,M186,M118      16)      40%')")
                write(6,"(' 7) Military dynamite,M1       17)      50%')")
                write(6,"('  Straight dynamite            18)      60%')")
                write(6,"(' 8)       40                   19) Teryl')")
                write(6,"(' 9)       50%                  20) Comp. B')")
                write(6,"('10)       60%                  21) Amatol 80/20')")
                write(6,"('11) PETN                       22) Black Powder')")
                write(6,"('12) Pentolite                  23) Nitrostarch')")
                write(6,"('Enter explosive type number  ',$)")
                read(5,"(i2)")exptyp
                if(iww.eq.1)write(7,"('Enter explosive type number ',i2)")exptyp
        endif
        return
        end

c starting information
        subroutine strtinfo(iww)
c     ans for Y/N answers and iww to toggle printing to fort.7
        character ans,anss
        iww=0
        iwww=0
        do 15, i6=6,7
        if(i6.ne.6.and.iwww.ne.1)goto15
        write(i6,"('This program makes peak level noise predictions for explosio
->->    ns and')")
        write(i6,"('possible effects of the predicted levels.  The program is us
->->    eful for')")
        write(i6,"('siting explosives operations and for assessing infrequent or
->->     unusual')")
        write(i6,"('explosives operations.  Note that any long term operations M
->->    UST be')")
        write(i6,"('assessed by the proceedures of AR 200-1 and the Intallation
->->    Compatible')")
        write(i6,"('Use Program.  This program can not be used over water.  All
->->    weights')")
        write(i6,"('are in kilograms, all distances in meters.  All throughout t
->->    his')")
        write(i6,"('program you will be asked (Yes/No) questions.  The computer
->->    reads the')")
        write(i6,"('first letter of your response so a y or n will suffice or yo
->->    u can just')")
        write(i6,"('hit a return to continue. All weights are in kilograms and a
->->    ll ')")
        write(i6,"('distances are in meters.  The program provides weather predi
->->    ctions')")
        write(i6,"('for three weather conditions and maximum level curve.')")
        if(i6.eq.7.and.iwww.eq.1)goto14
        write(6,"(' ')")
        write(6,"('Would you like to see a brief chart of these conditions? (Y/N
->->    ) -> ',$)")
        read(5,"(a)") anss
14      if((anss.eq.'y').or.(anss.eq.'Y'))then
                write(i6,"('')")
                write(i6,"('Negative gradient- Sunny day, cumulus clouds, mid da
->->    y, windy')")
                write(i6,"('')")
                write(i6,"('Base- Low winds, clouds, fall and winter, daytime')")
                write(i6,"('')")
                write(i6,"('Focus- Low stable clouds, very low winds(<2m/s), nig
->->    ht time to 2hrs.')")
                write(i6,"('after sunrise, winter and fall')")
                write(i6,"('')")
                write(i6,"('Maximum possible overpressure- Rare, but levels will
->->     sometimes')")
                write(i6,"('occur under extreme focus conditions.')")
                write(i6,"('')")
```

```
                  endif
                  if(i6.eq.7.and.iwww.eq.1)goto15
                  write(6,"('Do you want this introduction in a storage file? (Y/N)  > ',$
->->        )")
                  read(5,"(a)") ans
                  if((ans.eq.'y').or.(ans.eq.'Y'))iwww=1
->->        15    continue
                  write(6,"('Do you want this session to be put recorded in a storage file
->->        ? (Y/N) -> ',$)")
                  read(5,"(a)") ans
                  if((ans.eq.'y').or.(ans.eq.'Y'))iww=1
                  if((ans.eq.'y').or.(ans.eq.'Y'))write(6,"('ok it will be in fort.7')")
                  write(7,"('')")
                  write(7,"('These are the standard explosive types to be used.')")
                  write(7,"('1)  M1A1 bangalore torpedo')")
                  write(7,"('2)  M2A2 bangalore torpedo')")
                  write(7,"('3)  40 lb cratering charge')")
                  write(7,"('4)  M2A3  15 lb shaped charge')")
                  write(7,"('5)  M2A4  15 lb shaped charge')")
                  write(7,"('6)  M3    40 lb shaped charge')")
                  write(7,"('7)  M3A1  40 lb shaped charge')")
                  write(7,"('')")
                  write(7,"('These are the explosive types available, used for finding eff
->->        iciencies.')")
                  write(7,"(' 1) TNT                          Ammonia dynamite')")
                  write(7,"(' 2) Terytol,M1,M2              13)      40%')")
                  write(7,"(' 3) Comp.C3,M3,M5              14)      50%')")
                  write(7,"(' 4) Comp.C4,M5A1,M112          15)      60%')")
                  write(7,"(' 5) Ammonium nitrate             Gelatin dynamite')")
                  write(7,"(' 6) Sheet expl.,M186,M118      16)      40%')")
                  write(7,"(' 7) Military dynamite,M1       17)      50%')")
                  write(7,"('  Straight dynamite            18)      60%')")
                  write(7,"(' 8)       40                   19) Teryl')")
                  write(7,"(' 9)       50%                  20) Comp. B')")
                  write(7,"('10)       60%                  21) Amatol 80/20')")
                  write(7,"('11) PETN                       22) Black Powder')")
                  write(7,"('12) Pentolite                  23) Nitrostarch')")
                  write(7,"('')")
                  return
                  end
```

USA-CERL DISTRIBUTION

USAEHSC, ATTN: Library 22060
ATTN: DET III 79906

US Army Engineer Districts
ATTN: Library (18)

US Army Engineer Divisions
ATTN: Library (11)

US Army Europe
AEAEN-ODCS/Engr (2) 09403
AEUES 09081
V Corps
ATTN: DEH (12)
VII Corps
ATTN: DEH (16)
21st Support Command
ATTN: DEH (12)
USA Berlin
ATTN: DEH (10)
USASETAF
ATTN: DEH
Allied Command Europe (ACE)
ATTN: ACSGEB/Engr
ATTN: SHIHG/Engr

8th USA, Korea (19)
ATTN: Engr

ROK/US Combined Forces Command 96301
ATTN: EUSA HHC CFC/Engr

USA Japan (USARJ)
ATTN: DCSEN 96343
ATTN: Fac Engr 96343
ATTN: DEH-Okinawa 96331

416th Engineer Command 60623
ATTN: Facilities Engr

US Military Academy 10966
ATTN: Facilities Engineer
ATTN: MAEN-A

USA AMCCOM 61299
ATTN: AMSMC-RI
ATTN: AMSMC-IS

AMC - Dir., Inst., & Servc
ATTN: Environmental Office (22)

DLA ATTN: DLA WI 22304

DNA ATTN: NADS 20305

FORSCOM
FORSCOM Engr, ATTN: Spt. Det.
ATTN: Environmental Office (28)

HSC
Fitzsimons AMC 80045
ATTN: HSHG-DEH

USA AMCCOM 61299
ATTN: AMSMC-RI
ATTN: AMSMC-IS

MDW, ATTN: DEH (3)

NARADCOM, ATTN: DRDNA-F 01760

TARCOM, Fac. Div. 48090

TRADOC
HQ, TRADOC, ATTN: Environ. Office
ATTN: Environmental Office (18)

WESTCOM
ATTN: DEH, Ft. Shafter 96858
ATTN: APEN-A

Fort Belvoir, VA 22060 (6)
ATTN: Canadian Liaison Officer
ATTN: British Liaison Officer
ATTN: Australian Liaison Officer
ATTN: French Liaison Officer
ATTN: German Liaison Officer
ATTN: Engr Studies Center

CECRL, ATTN: Library 03755

WES, ATTN: Library 39180

HQ, XVIII Airborn Corps
and Fort Bragg
ATTN: AFZA-FE-EE 28307

Tyndall AFB, FL 32403
AFESC/Engineering & Service Lab

NCEL
ATTN: Library, Code L08A 93043

Defense Technical Info. Center 22314
ATTN: DDA (2)

SETAF Engineer Design Office 09019

Engr Societies Library, NY 10017

Natl Guard Bureau Instl. Div 20310

US Govt Print Office 22304
Receiving Sect/Depository Copies (2)

National Bureau of Standards 20899

ENA Team Distribution

Chief of Engineers
ATTN: CEHSC-EP
ATTN: CEEC-CE
ATTN: CEEC-EA
ATTN: CEEC-EI (2)
ATTN: CEEC-ZA
ATTN: CEEC-M (2)
ATTN: CEIM-SL
ATTN: CERD
ATTN: DAEN-ZCE
ATTN: DAEN-ZCI

HQ USAF/LEEEU 20332

AMC 22333
ATTN: AMCEN-A

Naval Air Systems Command 20360
ATTN: Library

Aberdeen PG, MD 21010
ATTN: Safety Office Range Safety Div.
ATTN: U.S. Army Ballistic Research Lab (2)
ATTN: ARNG Operating Activity Ctr.
ATTN: Human Engr Lab

Edgewood Arsenal, MD 21010
ATTN: HSHB-MO-B

NAVFAC 22332
ATTN: Code 2023

Naval Surface Weapons Center 22448
ATTN: N-43

US Army Aeromedical Res Lab. 36362
ATTN: SGRD-UAS-AS

Wright-Patterson AFB, OH 45433
ATTN: AAMRL/BB
ATTN: AAMRL/BBE

Human Engr. Laboratory 21010

Naval Undersea Center, Code 401 92132

Bureau of National Affairs 20037

Building Research Board 20418

Transportation Research Board 20418

Department of Transportation
ATTN: P-15 20590

Federal Aviation Administration 20591
ATTN: Director
ATTN: Science Advisor
ATTN: AEQ-110
ATTN: AEE-120 (2)

HQ FORSCOM
ATTN: AFEN-MSE

NASA
ATTN: Code QS

38

8/88